LABORATORY EXPERIMENTS ON THE EFFECTIVENESS OF STRAW MULCH ON SOIL DEGRADATION PROCESSES UNDER SIMULATED RAINFALL

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INTRODUCTION

Mulching cover has been used as a common management practice to improve water use efficiency and soil conservation in agricultural lands of semiarid regions characterized by irregular storm patterns with intense and short rainfall events.

OBJECTIVES:

- Evaluate in laboratory the effectiveness of mulching on reducing soil degradation and conserving soil water;
- Investigate the effect of distinct mulch densities on several relevant hydrological processes (e.g. runoff, sediment transport, soil moisture), by using multiple step intermittent rainfall events.

MATERIAL AND METHODS

Laboratory experiments (Fig.1) comprised a free drainage rectangular soil flume (3.0 × 0.3 m^2) at 10% slope gradient (Fig 2a) and a rainfall simulator (Fig. 2b) with a steady single downward–oriented full-cone.

A sequence of five multiple-step intermittent rainfall events, of different intensities and patterns (Fig. 4), was used to simulate rainfall conditions for the study. A fixed 30 min dry spell time interval was always assumed between two consecutive rainfall events, allowing runoff recession to occur, as well as soil drainage. A set of infrared bulbs placed above the soil flume were used to enhance evaporation during the dry spells (Fig. 2d).

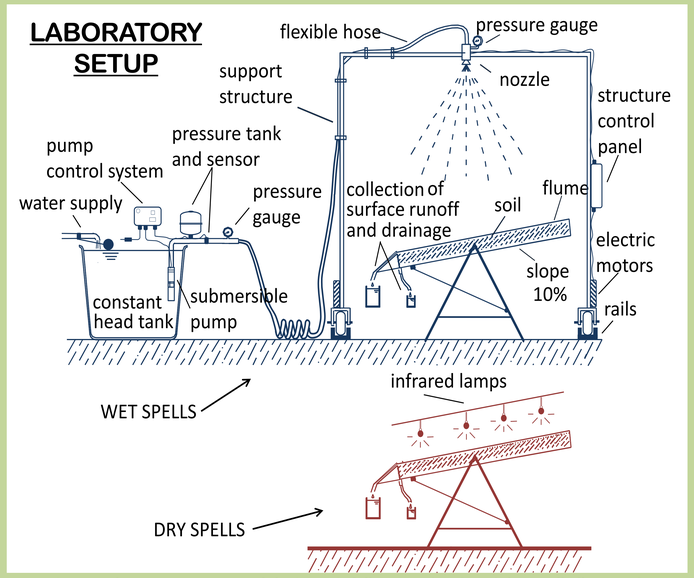

Fig. 1 - Laboratory setup used during rainfall events (top) and dry spells (bottom).

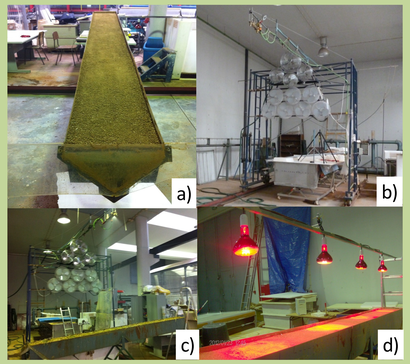

Fig. 2 - Photographs of the laboratory experiments: a) Soil flume; b) Rainfall simulator; c) Laboratory setup during the simulation of a rainfall event; and d) Infrared bulbs installed during a dry spell.

Fig. 3 - Soil flume surface photographs: a) Bare soil; b) Low mulching cover; and c) High mulching cover.

A sandy loam soil from the right bank of Mondego River (Coimbra, Portugal) was used as a sedimentary material for the experiments (Fig. 3a) and air dried rice straw was used as mulch (Fig. 3b and 3c). Three soil cover conditions were considered: i) bare soil, without mulching cover; ii) low mulching cover with 2 ton/ha density; and iii) high mulching cover with 4 ton/ha density.

RESULTS AND DISCUSSION

Results of the laboratory experiments for the sequence of five multiple-step intermittent rainfall events and for the three different soil cover conditions (bare soil, low mulching cover, and high mulching cover), are shown in Fig. 4. Rice straw mulching was highly efficient on controlling surface runoff and soil loss:

- Mulching covers of 2 ton/ha and 4 ton/ha produced reductions, respectively, of 21% and 51%, in the runoff peak. Such effect was more evident for the first rainfall event, where the initial soil moisture conditions were air dry soil;
- Mulching dramatically reduced erosion rates for all rainfall events., varying from 79% to 90% for, respectively, low and high mulching covers.

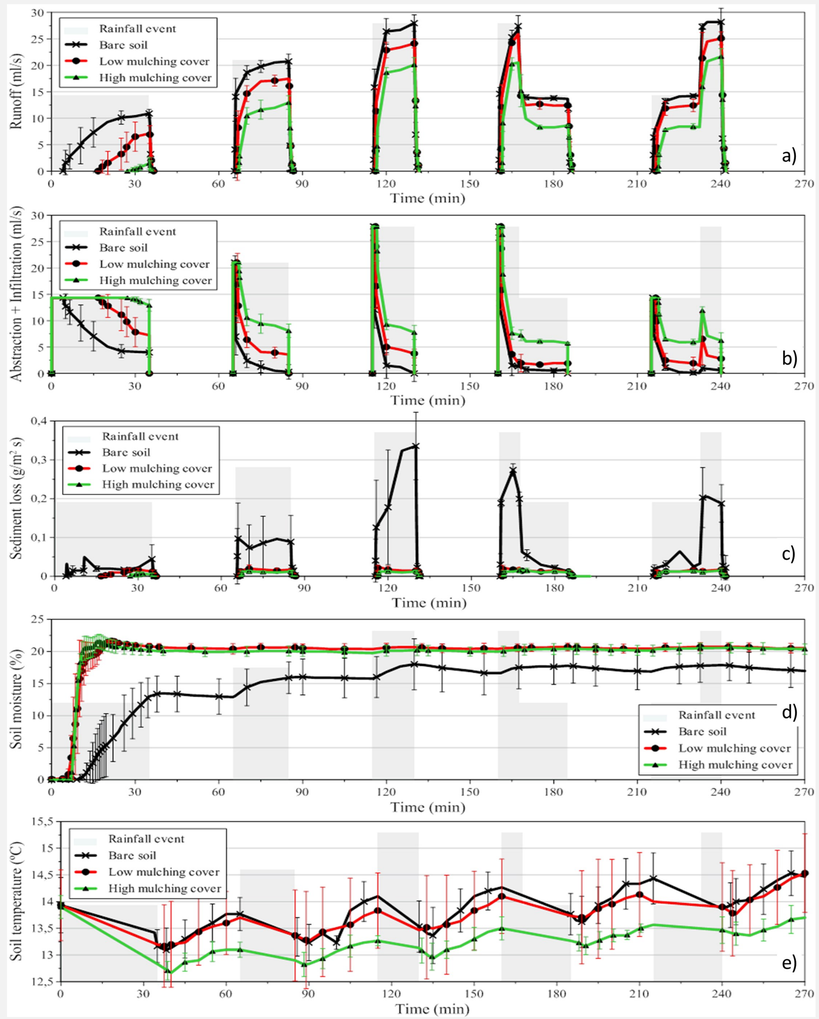

Fig. 4 – Results of laboratory experiments: a) runoff; b) infiltration plus abstraction; c) sediment loss; d) Soil moisture; and e) Soil temperature.

Mulching had a significant impact on soil moisture and soil temperature dynamics, not only during rainfall events but also during dry spells, when infrared bulbs were used:

- Both mulching cover densities promoted a buffer zone, reducing the effect of the infrared bulbs and dampening soil temperature and soil moisture fluctuations;
- Mulching cover density of 4 ton/ha controlled temperature better than the other soil cover treatments.

CONCLUSIONS

The results clearly show that rice straw mulching strongly affected infiltration, surface runoff and erosion. Mulching has conferred protection to the superficial layer of the soil, reducing the formation of rills and the transport of sediments, leading to the reduction of erosional and degradation processes. Higher hydraulic roughness due to the straw cover retarded surface flow, improved infiltration and enhanced soil moisture, being this of major interest in soil and water conservation when agricultural cropping is considered.

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